CHAPTER 3

Overview of Wisconsin's Biological Communities

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Determinants of Biodiversity

The location and extent of plant communities and the animals associated with them are determined by environmental gradients of moisture, temperature, soil type, and climate. They are also shaped by historical events, migration, and natural and human-induced disturbance. The most pronounced environmental gradient in Wisconsin is located in a narrow band that runs from northwestern to southeastern Wisconsin. This band has been termed the tension zone (Fig. 9). Many species of plants and animals reach the limit of their ranges in this zone. In Wisconsin, the tension zone delineates the northern forest, including the boreal element, from the southern forest and prairies. Although climate is a major reason for the tension zone, soil type and other factors also play a role.

Impact of Glaciation

The greatest historical event impacting Wisconsin vegetation occurred 10,000-60,000 years ago when Wisconsin was invaded by continental ice sheets. These glaciers transformed Wisconsin's landforms and vegetation. Vegetation was scoured away and mountains were planed down in all except the southwestern region of the state, leaving a rolling plain covered by a layer of glacial till. Remnants of Wisconsin's earlier topography are visible in hard rock outcrops such as Rib Mountain and the Baraboo Hills. Each interglacial period, including the present one, was revegetated through migration, which occurred through range extension and seed dispersal to favorable habitats. Migrants originated from communities centered as far away as the Ozarks, Pennsylvania, Texas and other areas. Some of the tree species now in Wisconsin had glacial refuges in the southern Appalachians and the eastern coastal plain. Although only a portion of species were able to perpetuate themselves over the long term, what is now Wisconsin regained tremendous floristic diversity through migration and colonization following glaciation. An additional component of floristic diversity is derived from the relict species occurring in the Driftless Area of southwestern Wisconsin. These species pre-date glacial activity and often exist nowhere else in the state.

The glaciers also had a tremendous influence on Wisconsin surface waters. Glacial deposits dammed rivers and scoured out lakebeds creating large water bodies such as the Great Lakes and Lake Winnebago. Some small water bodies were created by the numerous pits or depressions in the glacial till, which filled with groundwater. In the north, most are found in sandy, pitted outwash and were formed when buried ice blocks melted after retreat of the glacial ice. The nature of these aquatic features was determined, in large part, by their landscape position. For example, the landscape position of lakes in the groundwater and surface flow system determined their basic water chemistry.

Basic water chemistry, in turn, influenced and continues to influence the sensitivity of waters to eutrophication and such present-day concerns as mercury toxicity and acid rain. Landscape position has also influenced the species present in a given lake because it determines how connected that particular lake is to other lakes and sources of colonization. Thus, the glaciers created a template, or backdrop, on which present-day waters have developed.

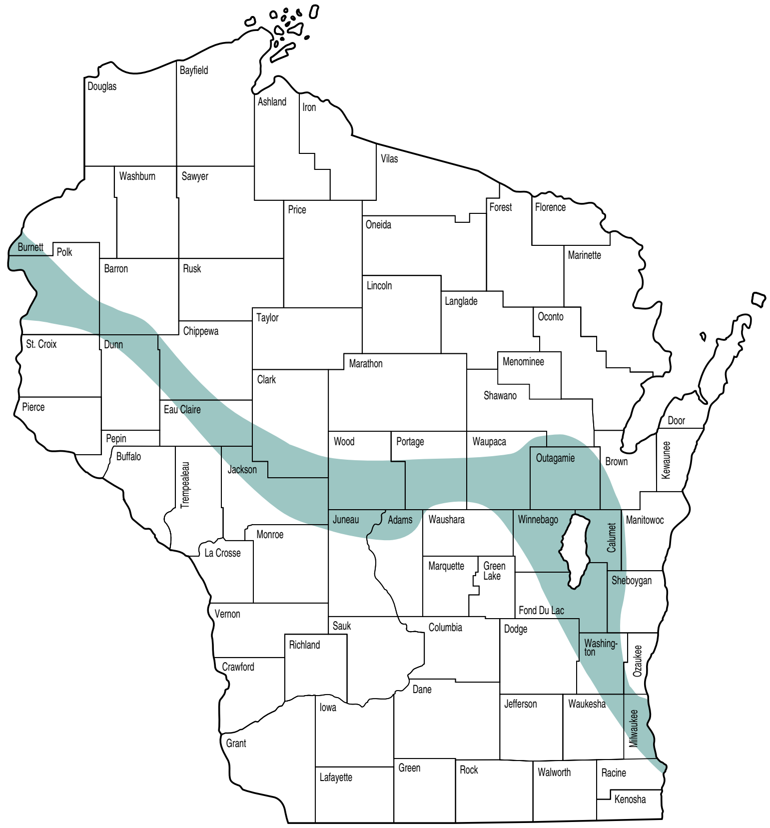

Figure 9

Location of the tension zone, adapted from Curtis (1959).

Impact of Other Natural Disturbance

Other types of natural disturbance have also influenced Wisconsin plant and animal communities. Chief among these have been windstorms, lightning-induced fire, and droughts, which were often a factor in severe fires. Floods have also influenced the natural communities, but to a lesser degree. Historically, all of these factors individually and in combination have impacted the landscape. Climate and temperature changes have greatly influenced the significance of these disturbances.

Windstorms frequently produced disturbance that varied in significance from a local to landscape scale. A recent example of this is on the Flambeau River State Forest, where much of the old growth was destroyed in a minimum of five different windstorms between 1949 and 1977. The most significant of these storms occurred in the downburst of 1977, when hundreds of thousands of acres across the state were disturbed. A much earlier example of climatic influence occurred during the warming period that followed the last glaciation. Floodwater from the melting glacier probably created extensive floodplains and terraces in south-central Wisconsin. The presence of prairie species in the pollen record of this period, plus an increase in charcoal, indicates an interspersion of dry periods and fire. The frequency, combination, and size of these disturbances continues to influence the mosaic of the natural communities.

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Human-Induced Disturbance

Human-induced disturbance had a profound impact on Wisconsin plant and animal communities, exceeded only by the impact of glaciation. For centuries before Euro-American settlement, Native Americans lived in the area now known as

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Wisconsin. Although the size of their populations and the extent to which they used the land are undocumented, both are probably far greater than once thought. Scientists estimate North American populations at 3.8 million or more at the time of European contact (Denevan 1992). The Wisconsin region no doubt supported large Native American populations due to its abundant natural resources.

Fire was one of the Native Americans' primary tools for managing these resources. Fire was used to concentrate game for hunting, increase game habitat, and clear paths for travel. Also, natural fires went largely unsuppressed. The result was development of extensive communities—prairies, savannas, barrens, and oak woodlands—that were fire-dependent and, in fact, a product of fire. Approximately 40%-45% of Wisconsin's land surface was covered by these fire-dependent communities prior to Euro-American settlement (Curtis 1959). The more mesic northern and southern forests were fire resistant, but their composition and structure were probably altered to some extent through intentional management by Native American populations.

The nature of the plant communities prior to European contact is unknown, although scientists continue to piece together a description based on the record left by pollen, sediment, and explorers' journals. The first systematic record of Wisconsin's vegetation communities was created in the mid-1800s, when the U.S. Geological Survey's land survey of Wisconsin was completed. This was some 350 years after contact, well after disease introduced by European explorers had decimated Native American populations. Vegetation maps based on the land survey records show a diversity of natural communities including extensive forests and wetlands plus the fire-dependent grassland, barrens, and savanna communities (Fig. 10). These communities are commonly referred to as Wisconsin's *presettlement* vegetation. This convention was adopted for our report.

Euro-American settlement marked the beginning of a simplification of Wisconsin's landscape and a decrease in biodiversity. In the absence of fire, the prairie, savanna, barrens, and oak woodland communities gradually filled in with shrubs and trees. When settlers realized the depth and richness of the prairie and savanna soils, these areas were cleared for agriculture and grazing, leaving only traces of the original plant communities. Forested areas were either cleared for farming or cut for timber as the need for building material surged at the turn of the century. Except for pockets of forest, northern Wisconsin was completely cut over. Slash timber left on the ground fueled unnaturally severe fires that further denuded the land and at times damaged the soil. The forest was slow to regenerate itself, and when it did, it was very different from the earlier forests.

Although the landscape was altered as Native Americans used resources and interacted with the land, changes reflected a level of human use many times less intensive than present-day use. Urbanization, highway construction, and the host of other developments associated with modern life have produced tremendous changes in Wisconsin's landscape. Fragmentation and simplification of plant communities and pollution have accompanied these changes. Impacts of these disturbances are discussed in more detail in the "Ecological Issues" section of this report.

Nineteenth century land surveying, a pen drawing from the collections of the State Historical Society of Wisconsin. *Illustration courtesy of Kenneth Lange.*

The Situation Today

Today, Wisconsin has forest cover roughly equal to that in place at Euro-American settlement, but it is very different in age structure and species composition. Barrens, savannas, and grasslands exist but only in scattered locations. *Postglacial* lakes and rivers have remained relatively constant in number and surface area, but we have lost about one-half of our wetlands along with the seasonal ponds associated with them. Most of what we have left of prairies, savannas, and certain wetlands (e.g., sedge meadows) is the result of managed use of fire, since these community types are fire-dependent.

> Today's remaining biological communities provide valuable sources of genetic and species diversity. Our challenge is to retain the range of diversity still present and, where possible, regain diversity through restoration.

Thus, today Wisconsin still has a great deal of biological diversity, but it has also lost a great deal of diversity (Fig. 11). All of today's communities provide valuable sources of genetic and species diversity. Our challenge is to retain the range of diversity still present and, where possible, regain diversity through restoration. In going about this work, we must strive to measure diversity in ways other than *species richness*. Understanding and measuring diversity at a functional level will put us in a better position to predict the impact of various actions on plant and animal communities.

The following sections of this report profile Wisconsin's seven major biological communities:

- northern forests
- southern forests
- oak and pine barrens
- oak savannas
- grasslands
- wetlands
- aquatic systems

These seven communities represent an aggregation of the more numerous communities described by Curtis (1959) (Table 1). Curtis' system of classifying vegetation was chosen as the framework for this report because it was designed specifically for Wisconsin and has stood the test of time. Recent interest in biodiversity and ecosystem management has spurred the development of a number of regional and national systems for classifying communities and ecosystems. One such system, the National Hierarchy of Ecological Units, has been adopted by the Department's Division of Resource Management as the standard for its work (U.S. Dep. Agriculture 1993). The Curtis system and others such as Kotar et al. (1988) will nest within this hierarchy, which is designed to stratify the Earth into progressively smaller areas of increasingly uniform ecological potentials. Thus, it can be used at multiple geographic scales ranging from a single site in our state to an area that spans several states or the entire nation. Maps depicting ecoregions and various other ecological units will be developed to assist in setting management goals and objectives.

In this report, each of the aggregated communities is described and compared to its presettlement status (for an overview of how rare each of the communities has become, see the global ranks in Table 1). After status, actions causing concerns and socio-economic issues related to conservation of each community are discussed, and the potential for restoring the community to a sustainable, functional state is assessed. Finally, possible actions are listed for managing and restoring each community. Note that some of Curtis's communities are discussed in more than one of the aggregated communities due to overlap in composition, structure, or function. Although the communities are categorized

Table 1. Wisconsin plant communities. Compiled by R. Henderson based on Curtis (1959) and the Wisconsin Natural Heritage Inventory.

Aggregations Used in this Report	Curtis (1959) Communities and their Global Rank*	Aggregations Used in this Report	Curtis (1959) Communities and their Global Rank*
Northern Forest	Boreal Forest (*G3*) Northern Dry Forest (*G3*) Northern Dry-Mesic Forest (G4) Northern Mesic Forest (G4) Northern Wet-Mesic Forest (*G3*) Northern Wet Forest[+](G4)	Grassland	Bracken-Grassland (G3) Sand Barrens Dry Prairie (G3) Sand Prairie** Dry Lime Prairie** Dry-Mesic Prairie (G3) Mesic Prairie (G2) Wet-Mesic Prairie (G2) Wet Prairie[+] (G3) Calcareous Fen[+] (G3) Southern Sedge Meadow[+] (*G3*) Northern Sedge Meadow[+] (G4)
Southern Forest	Southern Dry Forest (G4) Dry Oak Woodland** Southern Dry-Mesic Forest (G4) Mesic Oak Woodland** Southern Mesic Forest (*G3*) Southern Wet-Mesic Forest Southern Wet Forest[+]	Aquatic	Emergent Aquatic (G4) Submergent Aquatic Lake Beach
Oak Savanna	Oak Opening (G1) Dry Oak Opening** Dry-Mesic Oak Opening** Mesic Oak Opening** Wet-Mesic Oak Opening Wet Oak Opening** Cedar Glade	Wetland	Open Bog (G4) Alder Thicket (G4) Shrub Carr Northern Wet Forest (G4) Southern Wet Forest Wet Prairie (G3) Calcareous Fen (G3) Southern Sedge Meadow (G3) Northern Sedge Meadow (G4)
Oak/Pine Barren	Oak Barrens (*G2*) Pine Barrens (G3)	Minor Misc. (not covered in the report)	Exposed Cliff Shaded Cliff Lake Dune

* Rank reflects global rarity. Community classification is not standardized for the nation. Thus, not all of the communities have ranks, and some of the ranks had to be adapted to Wisconsin communities based on criteria for similar communities elsewhere. Also, some relatively low-ranked forest communities may be rare in some seral stages (i.e., specific occurrences of the community may be highly ranked). Ranks appearing in italics are considered tentative at this time.

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.

G2 = Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

G3 = Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single state or physiographic region) or because of other factors making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100.

G4 = Apparently globally secure, though it may be quite rare in parts of its range, especially at the periphery.

G5 = Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.

** Postulated communities. Due to their rarity, these communities cannot be rigorously quantified at this time.

[+] Also covered to some extent in the Wetland Communities.

Figure 10 (overleaf)

Vegetation cover of Wisconsin in the mid-1800s, compiled from U.S. General Land Office Notes by Robert W. Finley, 1976.

This map is based on the original land survey of Wisconsin carried out in the mid-1800s by the U.S. General Land Office. The purpose of the original survey was to establish the township-range-section grid for Wisconsin. For each section and quarter-section point, nearby trees were selected as bearing trees and their diameters and distances from the corner were recorded. In treeless areas, the crew built a mound of earth at the corner point and recorded that the point was in an open area. Surveyors were also required to describe the timber and agricultural value of the land, its topography, and water bodies and to provide a general description and map for each township (Lange, 1990).

These records were used by Robert W. Finley of the University of Wisconsin Extension to reconstruct the vegetation patterns present at the time of the survey. Dr. Finley completed his work in 1976. This map and others like it are useful in helping people visualize the general location, extent, and diversity of vegetation present in the last century.

Finley's map was originally designed and prepared by the Cartographic Laboratory, University of Wisconsin-Madison and was subsequently digitized by the University. The digital version presented in this report was further modified and enhanced by staff of the Department's Bureau of Information Management, GEO Services Section.

Figure 10

Vegetation cover of Wisconsin in the mid-1800s, compiled from U.S. General Land Office Notes by Robert W. Finley, 1976.

Figure 11

Land use and land cover for Wisconsin, compiled from high-altitude aerial photography taken from 1971-81.

Figure 11 (overleaf)

Land use and land cover for Wisconsin, compiled from high-altitude aerial photography taken from 1971-81.

This map is based on data from the U.S. Geological Survey Land Use Data Analysis Program. Data were interpreted from 1:58,000 scale color infrared and 1:80,000 panchromatic aerial photography from the National High Altitude Photography Program. Photographs were acquired in the years 1971-81.

The map is useful in helping people visualize the current land cover for Wisconsin and for assessing the magnitude of change over the past 100+ years. Although this map and the companion map on mid-1800s vegetation cover (Fig. 10) are based on very different types of data and technology, broad comparisons of cover types during the two time periods can be made.

Figure 11 was produced by the Bureau of Information Management, GEO Services Section.

according to the plants they support, the faunal element of each community is also discussed to the extent possible with existing information. Some of the most numerous and functionally important animal groups (e.g., insects) are the least documented or understood. Thus, animal coverage is inadequate but points the way for future work.

In discussing restoration, it is important to note that we do not envision restoring communities to conditions prior to Euro-American settlement. This would clearly be an unrealistic goal. The presettlement status of each community is an important indicator of site potential and serves primarily as a guide and benchmark in our restoration efforts. Our desired state is a more diverse landscape, considering all four levels of diversity (genetic, species, community, and ecosystem level) across all land uses.

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